519, 485

(12)特許協力条約に基づいて公開された国際出願

(19) 世界知的所有権機関
国際事務局

(43) 国際公開日
2004年1月15日 (15.01.2004)

PCT

(10) 国際公開番号
WO 2004/004992 A1

(51) 国際特許分類7: B26D 5/04, G01B 7/30

(21) 国際出願番号: PCT/JP2003/005001

(22) 国際出願日: 2003年4月18日 (18.04.2003)

(25) 国際出願の言語: 日本語

(26) 国際公開の言語: 日本語

(30) 優先権データ:
特願2002-195042 2002年7月3日 (03.07.2002) JP

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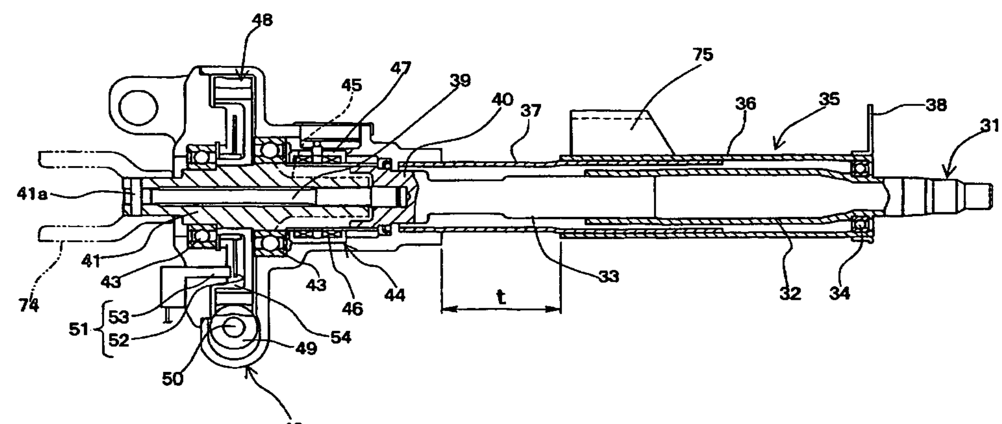
(81) 指定国 (国内): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) 指定国 (広域): ARIPO特許 (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), ユーラシア特許 (AM,

[続葉有]

(54) Title: MOTOR POWER STEERING SYSTEM

(54) 発明の名称: 電動パワーステアリング装置



(57) Abstract: A motor power steering system arranged to impart a steering assist force to the steering system of an automobile or a vehicle by the rotating force of a motor based on a steering torque detected by a torque sensor. With regard to a sensor for detecting the rotational angle of a steering shaft, the part being detected of the rotational angle sensor is disposed in a reduction gear and the detecting part of the rotational angle sensor is disposed on the outer side of the bearing of the reduction gear in the radial direction of the steering shaft.

(57) 要約: 本発明は、トルクセンサで検出された操舵トルクに基づいて、電動モータの回転力によって、自動車や車両の操舵系にモータによる操舵補助力を付与するようにした電動パワーステアリング装置に関する。そして、ステアリングシャフトの回転角を検出するための回転角センサに関し、回転角センサの被検出部を前記減速機内に設けるとともに、前記回転角センサの検出部を前記ステアリングシャフトの半径方向で前記減速機の軸受より外側に設けた。

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AZ, BY, KG, KZ, MD, RU, TJ, TM), ヨーロッパ特許 (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI 特許 (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

添付公開書類:
— 国際調査報告書

２文字コード及び他の略語については、定期発行される各*PCT*ガゼットの巻頭に掲載されている「コードと略語のガイダンスノート」を参照。

10/519485
DT12 Rec'd PCT/PTO 30 DEC 2004

7/prts

DESCRIPTION

MOTOR-DRIVEN POWER STEERING APPARATUS

Technical Field

The present invention relates to a motor-driven power steering apparatus structured such as to apply a steering assist force generated by a motor to a steering system of a motor vehicle or a vehicle, and more particularly to a rotation angle sensor for detecting a rotation angle (a steering angle) of a steering shaft.

Background Art

In order to reduce a fatigue of a driver and safely drive, a motor-driven power steering apparatus is generally mounted on the vehicle. The motor-driven power steering apparatus is structured such as to assist a load of the steering shaft and energize via a transmission mechanism such as a gear of a speed reduction gear or the like on the basis of a driving force of the motor.

As a conventional motor-driven power steering apparatus, an outline structure of the steering system is generally shown in Fig. 1. In the drawing, a steering shaft 1 having a steering wheel in a leading end (a right end in Fig. 1) is rotatably supported by a ball bearing 3 within a coaxial steering column 2, and is extended in an axial direction. The steering shaft 1 is constituted by a tubular outer shaft 4, and an inner shaft

5 fitted within the outer shaft 4. Further, the steering column 2 is formed by connecting a tubular outer column 6 and an inner column 7 press fitted and fixed within the outer column 6. Further, when an impact load is applied in a compression direction at a time of colliding, the outer shaft 4 and the outer column 6 are pressed into a base end side (a left side in Fig. 1), absorbs an energy by contracting an entire length and absorbs an impact applied to a body of the driver colliding with the steering wheel.

Further, an input shaft 9 and an approximately tubular output shaft 10 are connected to the base end side (the left side in Fig. 1) of the inner shaft 5 via a torsion bar 8. The torsion bar 8 is inserted into the output shaft 10, one end of the torsion bar 8 is press fitted and fixed to the input shaft 9, and the other end thereof is fixed to the output shaft 10 by a pin 11.

Further, a speed reduction gear unit 12 is supported to an outer periphery of a center portion of the output shaft 10 by a pair of ball bearings 13 and 13. The speed reduction gear unit 12 is constituted by a worm wheel 14 fixedly mounted to an outer periphery of the output shaft 10 in accordance with a press fitting, a worm 15 engaging with the worm wheel 14, and a motor in which the worm 15 is mounted to an output shaft 16, and is structured such as to reduce a speed of rotation of the motor via the worm 15 and the worm wheel 14 so as to transmit a torque, on the basis of driving the motor.

Further, a torque sensor 17 is arranged in a leading end side (a right side in Fig. 1) of the speed reduction gear unit 12, and the torque sensor 17 is provided with the torsion bar 8 and an electromagnetic yoke 20 receiving a coil winding 19 in an outer periphery of a spline groove 18 formed in a leading end of the output shaft 10, and is structured such as to detect a magnetic change by the coil winding 19 within the electromagnetic yoke 20, by generating a torsion angle in correspondence to a torque generated in the steering shaft 1.

Further, a rotation angle sensor (a steering sensor) 21 is arranged in a base end side (a left side in Fig. 1) of the speed reduction gear unit 12, and the rotation angle sensor 21 is constituted by a tubular hollow member 22 arranged in an outer periphery of the output shaft 10, and a casing 23 rotatably supporting the hollow member 22. In this case, in the hollow member 22, a projection 24 is extended to an inner side from an inner peripheral surface, and is engaged with a locking hole 25 provided in an outer peripheral surface of the output shaft 10, whereby the hollow member 22 is integrally rotated with the output shaft 10. Accordingly, the structure is made such as to detect the rotation angle of the output shaft 10 by detecting a relative displacement between the casing 23 and the hollow member 22 by a detecting means 26 provided in the casing 23. Accordingly, the steering state of the steering wheel is detected from the rotation angle (the steering angle).

In this case, reference numeral 27 denotes a universal joint for connecting to an intermediate shaft, and reference numeral 28 denotes a bracket for mounting the steering apparatus to the vehicle body.

In this case, in order to protect a passenger at a time when the vehicle is collided, it is necessary that an energy absorbing mechanism is provided in the steering column 2 for the regulation or the safety. Accordingly, in the conventional structure mentioned above, the steering shaft 1 and the steering column 2 are respectively constituted by two members (the outer shaft 4 and the inner shaft 5, and the outer column 6 and the inner column 7), and the outer shaft 4 and the outer column 6 can be moved at a certain range (a stroke t) in the axial direction at a time of collision. Therefore, the steering column 2 or the like is plastically deformed at a time of moving, and it is possible to absorb the energy generated at a time when the passenger collides with the steering wheel, on the basis of the deformation energy.

In this case, since the absorbing amount of the energy is determined by a product of a force applied by the impact and the stroke t, it is important to make the stroke t as long as possible in order to make the impact force to the passenger small so as to reduce an injury.

However, in the column type motor-driven power steering apparatus, it is necessary that the speed reduction gear and

the torque sensor 17 are provided in the axial direction of the steering shaft 1, and it is necessary that the rotation angle sensor 21 is provided so as to have such a space that the steering shaft, that is, the output shaft 10 is exposed between the universal joint 27 and the speed reduction unit 12. Accordingly, the stroke t is limited to a fixed length from the space of the vehicle body, and there is a problem that it is hard to secure the stroke t of the energy absorbing mechanism to a sufficient length in the limited space.

Accordingly, an object of the present invention is to provide a motor-driven power steering apparatus in which a rotation angle sensor can be attached to a steering shaft in the limited space without deteriorating an energy absorbing function for protecting the passenger.

DISCLOSURE OF THE INVENTION

The object mentioned above of the present invention can be effectively achieved by a motor-driven power steering apparatus structured such as to assist a steering force of a steering shaft via a transmission mechanism such as a gear of a speed reduction gear or the like by a rotation force of an electric motor on the basis of a steering torque detected by a torque sensor, comprising:

a rotation angle sensor for detecting a steering state of a steering wheel,

wherein a detected portion of the rotation angle sensor is provided within the speed reduction gear, and a detecting portion of the rotation angle sensor is provided in a radial direction of the steering shaft and in an outer side of a bearing in the speed reduction gear.

Further, the object mentioned above can be effectively achieved by the structure in which the detected portion is arranged in a worm wheel within the speed reduction gear, and the rotation of the worm wheel is detected by the detecting portion.

Further, the object mentioned above can be effectively achieved by the structure in which the detecting portion is mounted to a recess groove formed in any one side within the worm wheel within the speed reduction gear.

Further, the object mentioned above can be effectively achieved by the structure in which the detecting portion is arranged at a position opposing to a side surface of the detected portion, thereby detecting a magnetic or optical angle signal from the detected portion.

Further, the object mentioned above can be effectively achieved by the structure in which the detected portion is structured by a recess groove formed in any one side within the worm wheel within the speed reduction gear, and is constituted by a small gear provided in an inner peripheral surface of the recess groove.

Further, the object mentioned above can be effectively achieved by the structure in which the rotation angle sensor is constituted by an annular detected portion provided in the side surface of the worm wheel within the speed reduction gear, and a detecting portion provided at a position opposing to the detected portion.

Further, the object mentioned above can be effectively achieved by the structure in which the speed reduction gear is supported by a plurality of bearings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross sectional view showing an outline structure of a conventional motor-driven power steering apparatus;

Fig. 2 is a cross sectional view showing a structure of a motor-driven power steering apparatus in accordance with a first embodiment of the present invention;

Fig. 3 is a schematic view showing a rotation angle sensor provided in a speed reduction gear unit of the motor-driven power steering apparatus;

Fig. 4 is a cross sectional view showing a structure of a motor-driven power steering apparatus in accordance with a second embodiment of the present invention;

Fig. 5 is an enlarged view describing a detecting mechanism of a rotation angle of an output shaft in accordance with the

second embodiment;

Fig. 6 is a cross sectional view showing a structure of a motor-driven power steering apparatus in accordance with a third embodiment of the present invention; and

Fig. 7 is a view showing an outline structure of a rotation angle sensor in accordance with the third embodiment.

DESCRIPTION OF REFERENCE NUMERALS

31	steering shaft
35	steering column
39	torsion bar
40	input shaft
41	output shaft
42	speed reduction gear unit
43	bearing
44	torque sensor
46	coil winding
47	electromagnetic yoke
48	worm wheel
49	worm
51	rotation angle sensor
52	detected portion
53	detecting portion
61	core bar boss portion
62	gear base portion

63 resin gear

64 detected portion

65 rotation angle sensor

67 detecting portion

72 detecting gear

MODE FOR CARRYING OUT THE INVENTION

A description will be given below of embodiments in accordance with the present invention with reference to the accompanying drawings.

Fig. 2 shows a first embodiment of the present invention, and is a view showing an outline structure of a steering system. A steering shaft 31 rotating on the basis of an operation of a steering wheel is connecting by press fitting and fixing a solid cylindrical shaft-like inner shaft 33 to a tubular outer shaft 32. Further, the steering shaft 31 is rotatably supported at an end portion of a steering column 35 by a bearing 34 such as a deep groove type ball bearing or the like. The steering column 35 is connected by press fitting and fixing an inner column 37 to a tubular outer column 36.

The steering shaft 31 and the steering column 35 are structured such that when a great load is applied in an axial direction, the outer shaft 32 moves along the inner shaft 33 and the outer column 36 moves along the inner column 37 respectively in the axial direction within a range of the stroke

t in the axial direction so as to be plastically deformed. In other words, the steering shaft 31 and the steering column 35 are both structured by combining two members 32 and 33, and 36 and 37, and forms an energy absorbing mechanism structured such as to absorb an impact applied to a body of a driver colliding with the steering wheel.

In this case, in the embodiment mentioned above, the energy of the steering shaft 31 and the steering column 35 is absorbed by a plastic deformation at a time of relative movement between two members, however, it is possible to absorb the energy by the plastic deformation between the steering column 35 and a bracket 75 for fixing the steering column 35 to the vehicle body.

Further, an input shaft 40 and an approximately cylindrical output shaft 41 are connected to a base end side (a left side in Fig. 1) of the steering shaft 31 via a torsion bar 39. The torsion bar 39 is inserted into the output shaft 41, one end thereof is press fitted and fixed to the input shaft 40, and the other end thereof is fixed to the output shaft 41 by a pin 41a.

Further, a speed reduction gear unit 42 is supported in an outer periphery of the output shaft 41 by a pair of ball bearings 43 and 43, and a torque sensor 44 is arranged in a leading end side (a right side in Fig. 1) of the speed reduction gear unit 42. The torque sensor 44 is provided with the torsion bar 39, and an electromagnetic yoke 47 arranged in an outer periphery

of a spline groove 45 formed in a leading end of the output shaft 41 and receiving a coil winding 46, and is structured such as to detect a magnetic change by the coil winding 46 within the electromagnetic yoke 47 by generating a torsion in the torsion bar 39 in correspondence to the torque generated in the steering shaft 31.

Further, the speed reduction gear is constituted by a worm wheel 48 fixedly mounted to an outer periphery of the output shaft 41 in accordance with a press fitting, a worm 49 engaged with the worm wheel 48, and a motor mounting the worm 49 to the output shaft 50, and is structured such as to reduce a speed of the rotation of the motor via the worm 49 and the worm wheel 48 by driving the motor so as to transmit the torque.

Further, the rotation angle sensor 51 is constituted by a thin disc-like detected portion 52 provided within the speed reduction gear unit 42 and having a smaller diameter than the worm wheel 48, and the steering shaft 31, that is, a detecting portion 53 provided in an outer side of the bearing 43 in a radial direction of the output shaft 41, as shown in Fig. 3. The detecting portion 53 is arranged at a position opposing to a side surface of the detected portion 52, and is integrally mounted to the output shaft 41 within a recess groove 54 formed in any one side within the worm wheel 48. Further, the detecting portion 53 is structured such as to detect the rotation angle of the output shaft 41 by detecting an angle signal from the detected

portion 52 in a magnetic manner or an optical manner, or an electric resistance manner or an electrical capacitance manner.

Accordingly, in the first embodiment mentioned above, the detected portion 52 of the rotation angle sensor 51 is provided within the speed reduction gear unit 42, and the detecting portion 53 is provided in the outer side of the ball bearing 43 in the radial direction of the output shaft 41. Accordingly, it is not necessary that the exclusive space for mounting the rotation angle sensor is provided on the steering shaft 31. As a result, it is possible to make the stroke t of the energy absorbing mechanism, that is, a distance in the axial direction by which the outer column 36 of the steering column 35 moves along the inner column 37 long. As a result, even in the case that the length in the axial direction on the steering shaft 31 is limited, such as the column type motor-driven power steering apparatus or the like, it is possible to secure a sufficient stroke t in the axial direction even if the rotation angle sensor 51 is provided in the steering shaft 31, whereby the energy absorbing capacity with respect to the impact load is not sacrificed.

Further, Fig. 4 shows a second embodiment in accordance with the present invention. A description of the second embodiment will be omitted by attaching the same reference numerals as those of the first embodiment to the same members. In Fig. 4, the worm wheel 48 is constituted by an approximately ring-like core rod boss portion 61, a gear base portion 62

integrally formed in an outer peripheral side of the core rod boss portion 61 by a resin, and a resin gear 63 formed in an outer peripheral side of the gear base portion 62 and engaged with the worm 49. Further, a recess groove is formed in a left side in Fig. 4, in the worm wheel 48, and a detected portion 64 constituted by a small gear is formed within the recess groove and in an inner peripheral side of the gear base portion 62. Accordingly, a rotation angle sensor 65 of the output shaft 41 is constituted by the detected portion 64 and a detecting portion 67 for detecting the rotation of the output shaft 41. Further, the detecting portion 67 is provided with a protruding shaft 71 extending from a main body 68 arranged in an outer side of the speed reduction gear unit 42 into the speed reduction gear unit 42 via an insertion hole 70 of a housing cover 69, and a detecting gear 72 mounted to a leading end of the protruding shaft 71. Accordingly, the rotation angle sensor 65 is structured, as shown in Fig. 5 in an enlarged manner, such as to detect the rotation of the output shaft 41 by the main body 68 from the detecting gear 72 via the protruding shaft 71, in accordance with an engagement between the detecting gear 72 of the detecting portion 67 and the small gear constituting the detected portion 64.

Accordingly, the detected portion 64 of the rotation angle sensor 65 is provided within the speed reduction gear unit 42, and the detecting portion 67 is provided in the outer side of

the bearing 43 of the speed reduction gear unit 42 in the radial direction of the output shaft 41. Therefore, even in the case that the rotation angle sensor 65 is provided in the steering shaft 31, it is possible to sufficiently secure the stroke t of the energy absorbing mechanism, and the energy absorbing capacity is not sacrificed. Accordingly, the same operations and effects as those of the first embodiment mentioned above can be achieved even by the second embodiment.

Further, Fig. 6 shows a third embodiment in accordance with the present invention. A description of the third embodiment will be omitted by attaching the same reference numerals as those of the first embodiment to the same members. In Fig. 6, the rotation angle sensor 65 is constituted by an annular detected portion 64 provided in a side surface of a leading end side (a right side in Fig. 6) of the worm wheel 48, and a detecting portion 67 provided at a position opposing to the detected portion 64, as shown in Fig. 7.

Accordingly, the detected portion 64 of the rotation angle sensor 65 is provided within the speed reduction gear unit 42, and the detecting portion 67 is provided in the outer side of the bearing 43 of the speed reduction gear unit 42 in the radial direction of the output shaft 41. Therefore, even in the case that the rotation angle sensor 65 is provided in the steering shaft 31, it is possible to sufficiently secure the stroke t of the energy absorbing mechanism, and the energy absorbing

capacity is not sacrificed. Accordingly, the same operations and effects as those of the first and second embodiments mentioned above can be achieved even by the third embodiment.

In this case, in figs. 2, 4 and 6, reference numeral 74 denotes a universal joint for connecting to an intermediate shaft, and reference numeral 75 denotes a bracket for mounting the steering apparatus to the vehicle body.

As mentioned above, in accordance with the motor-driven power steering apparatus on the basis of the present invention, in the case that the rotation angle sensor for detecting the steering state of the steering wheel is provided, the detected portion is provided in the worm wheel or the like within the speed reduction gear, and the detecting portion is provided in the outer side of the bearing of the speed reduction gear in the radial direction of the steering shaft. Therefore, the rotation angle of the steering shaft is detected by utilizing the worm wheel of the speed reduction gear and detecting the angle signal from the detected portion provided in the worm wheel by the detecting portion while using the magnetic or optical method, or the like. As a result, it is not necessary that the exclusive space for arranging the rotation angle sensor is provided in the axial direction of the steering shaft, and it is possible to effectively utilize the stroke of the energy absorbing mechanism. Accordingly, even in the case that the rotation angle sensor is provided in the limited space in the

axial direction of the steering shaft, such as the column type motor-driven power steering apparatus or the like, it is possible to keep a safety with respect to the impact load generated at a time of the collision of the vehicle or the like, without sacrificing the energy absorbing capacity.